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INDUCED VARIABILITY BY GAMMA IRRADIATION IN ISABGOL (*PLANTAGO OVATA* FORSK)

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ABSTRACT

Plantago ovate is a medicinal herb, requires improvement in seed yield to meet global demand for its seed husk. Mutation breeding has been attempted on account of the narrow genetic base of the crop. Seeds of isabgol variety RI-89 were treated with 9 doses of gamma rays(15 kr – 135 kr). Variability for seed yield and yield related characters were estimated in the M_2 generation. The treatment 30 kr and 60 kr increased the seed yield along with a number of spikes per plant and biological yield per plant. The maximum swelling factor was recorded in 135 kr. Disease infestation decreased in all the families and phenolic compound was increased. The CV increased in all the characters indicating the induction of variability by gamma rays. Mean as well as variance were shifted in both positive and negative direction.

KEYWORDS*: *Gamma Irradiation, Mutation Breeding, Phenolic Compounds & Negative Micro Mutation

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INTRODUCTION

Isabgol is an allogamous plant belongs to family Plantaginaceae. It is an important plant cultivated for seed and husk. In the Indian system of medicine, husk has been used for centuries. Isabgol husk provides an organic laxative prescribed in medicine as a cure in dysentery, diarrhea and habitual constipation (Mehta et al., 1976). India ranks first in production and trade of isabgol in the world market but is not able to meet the global demand due to low productivity. The crop improvement through the conventional method of plant breeding like selection, hybridization, and induced polyploidy have not resulted in any major breakthrough for yield due to the narrow genetic base of the crop on account of a small number of chromosomes with a lot of heterochromatin, low chiasma frequency and high selfing rate (Sareen and Koul, 1999). Looking to the above fact the mutation breeding is the only way for inducing genetic variability. In the present study, assessment of induced polygenic variability has been made through various estimates like mean, range and coefficient of variation (CV) in respect of different plant characters.

MATERIALS AND METHODS

Two generation selfed seed of variety RI-89 received from AICRP on Medicinal and Aromatic Plants, Rajasthan College of Agriculture, MPUAT, Udaipur were irradiated with various doses of gamma rays *viz.*, 15, 30, 46, 60, 75, 90, 105, 120 and 135 kr by exposing to a ^{60}CO source at a dose rate of 3.92 kr per minute at IARI, New Delhi. The treated seed along with control was sown in the field in a randomized block design with three replications at the experimental farm of Rajasthan College of Agriculture, Udaipur. Each treatment was planted in

four rows of 3mter length. In M_1 twenty randomly selected normal appearing plants were selfed and harvested individually to raise M_2 Generation in each treatment. The M_2 family was raised in a compact family block design with three replications. Each treatment was considered as family and each plant within treatment as progeny. Progenies were sown in single row plot of four-meter length at 30 cm apart. All the recommended agronomical practices were adopted to raise the healthy crop. To assess the disease no fungicides were used. The data were recorded for 14 characters in the M_2 generation and subject to statistical analysis.

RESULTS AND DISCUSSIONS

Between families mean square was significant or all the 14 characters in the M_2 generation and progeny difference within a family were also significant for all the characters in most of the families (Tabel 1). Days to 50 % flowering was delayed in all the families while days to 75% maturity was early at lower doses *viz.,*15 kr and 30 kr and late in higher doses *viz.,* 105 kr and 120 kr. Days taken from flowering to maturity (Reproductive phase) were shortened in almost all the families except 60 kr and 105 kr. Patel et al (1981)suggested the use of 40 kr and 80 kr gamma rays dose for efficiently inducing variability for maturity and synchronization in isabgol.

Table 1: Compact Family Block Design Mean Squares for Different Characters in M_2 Generation

S. No.	Characters	Replication [2]	Between Family [9]	Within Family										Error [398]
				Control [19]	15 kR [19]	30 kR [19]	45 kR [19]	60 kR [19]	75 kR [19]	90 kR [19]	105 kR [19]	120 kR [19]	135 kR [19]	
1	Days to 50% flowering	9.60**	134.90**	3.97	11.30**	11.82**	9.87**	2.93	5.34	7.03	14.11**	13.20**	16.01**	4.71
2	Days to 75% maturity	8.28*	264.36**	6.85	13.79**	11.31**	15.64**	5.92	11.00**	8.92**	15.77**	11.09**	9.31**	4.51
3	Reproductive phase	12.81	260.17**	10.76	9.21	21.14**	16.42*	5.02	10.86	11.21	19.61**	12.71	13.44	8.63
4	Plant height	11.30**	256.99**	4.64	6.1	14.06**	8.83*	7.94	12.22**	9.95*	4.92	7.69	11.53**	5.27
5	No. of tillers/plant	0.76**	35.20**	0.38	0.56	0.60*	0.60*	0.43	0.46	0.31	0.22	0.58*	1.58**	0.35
6	Number of spikes/plant	58.51	730.85**	10.72	106.02**	133.58**	122.00**	84.40**	100.37**	55.65	60.86	85.64**	137.79**	42.08
7	Spike length	0.81*	18.95**	0.35	0.47	0.41	0.53	0.7	0.87*	0.47	0.47	0.64	0.47	0.45
8	Biological yield/plant	43.10**	190.87**	11.76	21.32	37.56**	26.52*	30.97*	30.66*	13.09	17.23	22.41	32.30**	16.21
9	Seed yield/plant	2.57	24.55**	0.55	5.81**	6.79**	4.76**	3.88**	6.56**	3.04*	3.93**	2.19	5.23**	1.71
10	Harvest index	51.5	131.28**	13.54	64.70**	44.64*	63.94**	26.73	97.27**	41.35*	59.57**	58.33**	67.64**	25.57
11	TPC in leaves	0.00	0.16**	0.00	0.01**	0.03**	0.03**	0.02**	0.03**	0.01**	0.01**	0.00**	0.00**	0.00
12	Swelling factor	0.8	41.29**	0.59	4.57**	2.20**	7.12**	343**	7.86**	6.66**	4.96**	8.92**	7.28**	0.56
13	PDI at 65 DAS	141.33*	10463.60**	93.42	840.35**	566.95**	672.72**	286.81**	749.81**	708.83**	567.28**	392.65**	34.75	87.97
14	PDI at 90 DAS	286.45**	4620.59**	152.86	1052.79**	1168.77**	1374.25**	745.70**	1820.34**	767.71**	1016.97**	502.39**	1218.58**	136.95

***,** Significant at 5%and 1% level of significance, respectively**
TPC = Total phenollic compounds
PDI = Percent disease index
[ ] = Degree of freedom

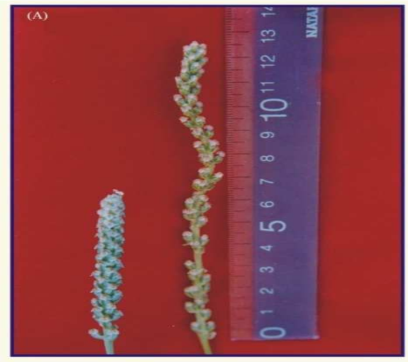
Plant height and number of tillers per plant *decreased* significantly in all the families except 45 kr where plant height was stimulated. Sareen and Koul (1991) also observed the stimulatory effect on plant height at lower doses and progressively reduction in tillers count with higher doses. The Maximum number of spikes per plant, biological yield per plant and seed yield per plant in 30 kr and 60 kr family while spike length was maximum in 60 kr and harvest index in 30 kr family. Total phenolic compounds in leaves increased and diseased intensity decreased in all the families except 120 kr. Family 135 kr and 75 kr were having least downy mildew disease infestation at 65 and 90 days after sowing (DAS). Family 75 kr was also having some downy mildew disease, free progenies. A significantly high swelling factor was observed in 135 kr, 105 kr and 90 kr families.

It is apparent from the table 2 that means of the characters shifted both in lower and higher direction and the effect of gamma rays on plant characters was not linear. The erratic or differential response of gamma rays was also reported by Sareen and Koul (1999), Lal and Sharma (2002), Bhagat and Hardas (1980), Verma and Singh (1984) a Patel and Dalal (1990).

Table 2: Mean (M), Range (R) and Coefficient of Variation (CV) of Different Characters of Isabgol in M_2 Generation

S. No	Treatment		Day to 50% Flowering	Days to 75% Maturity	Reproductive Phase (days)	Plant Height (cm)	No. of Tillers/ Plant	No. of Spikes/ Plant	Spike Length (cm)	Biological Yield/ Plant (g)	Seed yield/ Plant (g)	Harvest Index (%)	Total Phenolic Compounds (mg/g)	Swelling Factor (cc/g)	PDI at 65 DAS	PDI at 90 DAS
1.	Control	M	70.95	111.22	40.27	34.48	6.17	31.42	3.50	17.80	3.93	22.41	0.23	10.2	47.20	73.53
		R	69.0-73.0	108-113.7	36.7-43.7	32.2-37.7	5.7-6.9	25.9-33.8	2.8-4.0	13.8-21.3	3.3-4.6	17.9.25.7	0.22-0.26	9.5-10.9	37.3-57.3	61.3-86.7
		CV	2.81	2.35	8.15	6.25	9.99	10.42	16.85	19.27	18.85	16.42	8.16	7.52	20.48	16.81
2.	15 kR	M	73.57	109.92	36.35	33.70	4.45	30.61	4.36	18.62	4.33	22.64	0.24	10.79	51.67	71.80
		R	71.3-78.0	106.3-115.3	33.3-40.7	29.8-36.0	3.7-5.5	21.6-42.0	3.8-5.4	13.2-24.0	2.3-7.4	13.9-30.6	0.14-0.32	9.0-14.2	13.3-72.0	38.7-98.7
		CV	4.57	3.38	8.35	7.33	16.77	33.64	15.67	24.80	48.3	35.53	32.10	19.81	56.11	45.19
3.	30 kR	M	74.63	109.48	34.85	32.37	5.50	35.61	4.31	20.89	5.4	25.34	0.35	10.0	37.0	59.0
		R	71.7-79.0	104.7-112.6	29.7-39.0	28.2-36.4	4.8-6.3	24.7-47.6	3.7-5.3	15.2-28.8	3.1-8.7	18.0-33.8	0.19-0.49	8.5-12.0	13.3-65.3	12.0-89.3
		CV	4.61	3.07	13.19	11.58	14.07	32.46	14.92	29.21	48.30	26.37	47.45	14.81	64.35	57.94
4.	45 kR	M	75.22	110.58	35.37	35.88	4.55	32.24	4.41	18.31	4.19	22.77	0.32	9.97	37.80	69.0
		R	72.3-79.0	107.3-114.0	31.7-41.3	33.1-39.0	3.9-5.7	23.1-47.9	5.6-5.2	15.5-26.5	2.1-6.9	12.9-34.7	019-0.60	8.2-13.8	12.0-66.7	20.0-98.7
		CV	4.18	3.58	11.46	8.28	17.00	34.25	16.51	28.13	52.06	35.11	54.63	26.77	68.62	53.73
5.	60 kR	M	72.83	113.60	40.77	32.50	5.44	33.76	5.46	21.95	5.26	23.98	0.31	9.59	27.67	58.47
		R	71.3-74.7	111.0-116.6	38.7-43.3	29.3-35.5	4.9-6.2	24.7-44.8	4.5-6.3	16.9-29.9	3.5-7.2	17.9-29.3	0.20-0.54	8.0-11.7	20.0-76.0	29.3-81.3
		CV	2.35	2.14	5.50	8.56	12.02	27.21	15.32	25.35	37.44	21.60	42.54	19.32	61.21	46.71
6.	75 kR	M	74.28	112.80	38.52	32.55	4.56	31.90	4.29	18.6	4.51	23.95	0.36	10.01	20.27	49.27
		R	71.7-76.3	110.3-117.0	35.0-42.0	29.3-37.8	4.1-5.4	23.5-40.9	3.5-5.5	12.8-25.9	2.2-7.7	12.0-37.6	0.21-0.59	7.5-13.0	0.00-50.7	9.3-85.3
		CV	3.11	2.94	8.56	10.74	14.93	31.40	21.71	29.65	56.05	41.18	46.95	28.01	135.11	86.60
7.	90 kR	M	73.65	110.72	37.07	31.50	4.57	33.02	4.18	18.86	4.48	23.6	0.25	11.47	41.60	67.47
		R	71.7-76.0	106.3-112.7	34.0-40.7	27.5-35.7	4.1-5.1	26.1-40.6	3.4-4.8	15.2-24.4	2.6-6.1	16.2-30.2	0.17-0.36	8.3-14.3	16.0-76.0	24.0-88.0
		CV	3.60	2.70	9.03	10.01	12.20	22.59	16.41	29.19	38.89	27.24	38.05	22.50	64.0	41.11
8.	105 kR	M	76.05	116.35	40.30	30.55	3.99	27.08	4.14	16.49	4.09	24.22	0.28	11.73	41.20	62.73
		R	72.3-79.3	109.7-120.0	34.0-45.0	28.8-33.9	3.1-4.4	14.7-36.0	3.4-4.8	11.2-20.8	1.9-6.2	15.1-29.9	0.20-0.43	9.5-14.2	22.7-66.7	33.3-86.7
		CV	4.94	3.41	10.96	7.26	11.68	28.81	16.49	25.18	48.74	31.87	36.82	19.00	59.32	50.83
9.	120 kR	M	75.72	113.33	37.62	29.40	4.03	23.59	4.13	16.36	3.30	20.46	0.22	10.37	55.47	78.33
		R	73.3-79.7	110.3-116.7	32.7-40.3	25.6-32.4	3.4-5.1	11.8-32.4	3.3-4.9	11.6-21.5	1.9-4.6	11.9-32.2	0.18-0.30	8.0-14.7	34.7-72.0	54.7-96.00
		CV	4.80	2.94	9.48	9.43	18.98	39.23	19.44	28.93	44.84	37.33	37.90	28.81	35.72	28.61
10.	135 kR	M	74.62	112.95	38.33	29.7	3.77	28.99	3.38	17.39	3.77	21.12	0.34	11.94	14.53	58.40
		R	71.3-78-3	110.7-116.3	32.3-40.3	26.1-33.7	2.7-5.4	16.9-43.4	2.5-4.2	11.6-23.6	1.5-5.6	13.3-29.1	0.28-0.43	8.7-14.3	6.7-20.0	28.0-93.3
		C.	5.36	2.70	9.56	11.41	33.36	40.49	20.33	32.68	60.69	38.94	19.36	22.58	40.6	59.77
GM			**74.15**	**112.10**	**37.94**	**32.31**	**4.70**	**30.82**	**4.22**	**18.54**	**4.32**	**23.05**	**0.29**	**10.61**	**37.44**	**64.79**
CD 5% for Mean			**0.779**	**0.762**	**1.0555**	**0.824**	**0.213**	**2.329**	**0.241**	**1.445**	**0.470**	**1.815**	**0.006**	**0.270**	**3.367**	**4.201**

A coefficient of variation increased over the control in all families for all the traits indicating that gamma rays widened the range of variation for all the traits. The variability induced by gamma rays were maximum for per cent disease index at 65 and 90 DAS followed by seed yield per plant, total phenolic compounds and number of spikes per plant as compared to other traits. However, days to 50% flowering, days to maturity, reproductive phase and plant height were having the low amount of variability. Family 135 kr and 75 kr induced the higher amount of variability for the above characters as compared to other treatments. Family 135 kr induced maximum amount of variability for a number of spikes per plant, biological yield per plant and seed yield per plant but was having lower mean value for the traits as compared to other treatments. The reason could be the induction of a higher degree of sterility or accumulation of negative micro mutations at higher doses. Besides the alteration in means and variances of quantitative and qualitative characters, gamma rays induced different types of morphological deformities *viz.,* (A) elongated spikes (B) Paired spikes (C) sterile spikes (D) densely haired spikes (E) broadened leaves (F) branched spikes and (G) malformed leaves and spikes in M_2 generation (Figure 1). The morphological deformities were high at higher doses of radiation, which might be due to a higher degree of chromosomal aberrations.



(A) Normal and Elongated Spike

(B) Pared Spikes

(C) Sterile Spikes

(D) Densely Haired Leaves

(E) Broadened Leaves

(F) Branched Spikes

(G) Malformed Leaves and Spikes

Figure 1: Different Types of Morphological Mutants in *Plantago Ovate*

The alteration in mean and variance for yield related characters can be exploited to select superior genotypes (Sareen and Koul, 1991). In the present investigation, 22 progenies exhibited significantly higher seed yield than control. One hundred thirty superior plants were selected based on higher seed yield from different families. The maximum 30 plants were from 30 kr families. The average seed yield of these 130 plants was 2.45 times more than the control. Sareen and Koul (1999) reported 220 per cent increased in seed yield of the genotypes isolated from 20 kr dose of gamma rays treatment in the M_2 generation and Lal et al., (1998) isolated new isabgol cultivar “Niharika” from the M_4 generation of gamma-irradiated seed. Thus mutation breeding may be worthwhile for improvement of isabgol.

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